Magnetic topology change during large-amplitude Alfvénic oscillations driven by energetic beam ions in a tokamak plasma

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Using high-performance supercomputers, the MHD-PIC hybrid code MEGA has recently reproduced sequences of so-called Abrupt Large Events (ALE) [1] as observed in experiments on the JT-60U tokamak [2,3]. ALEs are short intense bursts of Alfvén wave activity driven by resonant interactions with energetic beam ions. The relevant beams in JT-60U had a combined power of up to 5 MW and accelerated deuterons to energies up to 400 keV. ALEs are important because they cause a significant amount of particle transport [4,5], and the recent hybrid simulations offer a way to study the underlying physical processes. Here, we report the latest insights obtained from Poincaré analyses of the magnetic topology during simulated ALEs. In particular, it is found that magnetic islands form during ALEs in the simulation. Potentially important implications for the transport and confinement of both the thermal background plasma and energetic ions are discussed. Moreover, it is noted that the topology of energetic ion orbits can differ significantly from that of the magnetic field, because energetic ions drift across the magnetic lines of force due to the curvature and gradients of the field. These drifts are also known to have a strong effect on relativistic “runaway” electrons produced by magnetic reconnection during disruptive events [6,7].

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